MOBILE NUCLEAR ENERGY POWER PLANTS FOR TURKEY
AND III. WORLD

Hüseyin ÖZDEN
Mechanical Engineering Dep., AKÜ, Usak/Turkey

ABSTRACT
It is estimated that if there is no alternative energy source, there will be increase in building
nuclear energy power plants. This source of energy and know how along with technology must
be put into the possession of Turkey. Since almost all of Turkey is 1st degree earthquake region
and in view of the regional political instability, the requirement of ample amount of water for
prolonged times, the density of settlement, environmental problems, high cost of building
nuclear energy power plants it becomes necessary to think about their application techniques.
In this study, mobile nuclear energy power plants having a wide area of use in conditions
prevailing in Turkey, their draft drawings for making them by using metal/steel are shown. The
positive-negative aspects of the topic is presented for discussions.

I. INTRODUCTION
For development, industrialisation, increasing the chance of competing the commodities and
services produced in the world market, there is need for economic, continues and sufficient,
environmentally safe energy. Because of increase in energy costs, persisting decrease in
reserves, it is expected that in near future, there will be energy crises. In making assessments,
the damages made by the furnace, chimney and exhaust surpluses to the nature because of
burning foil based fuels and to the balance of nature must not be overlooked. In the long run, to
prevent the difficulties to be created in a near future both in industry and in daily life by the
electric energy there is need for generation of nuclear energy. This need is prevailing for Turkey
and for many countries and for IIIrd World countries where there is limited energy sources. It is
a known fact that the fossil-based energy sources are limited in quantity. (Figure 1), show the
increase expected to occur in energy consumption prices in a near future because of this
increasing demand despite the available sources. /1-6/. Having studies related to nuclear energy
power plants become dense, preparation of infrastructure and putting them into the phase of
application are things that should be done as soon as possible. It is an error to index the energy
need of Turkey to Russian natural gas. To reduce the probable political and economic pressures
that may arise in future become of unavoidable dependence to external sources in energy sector
at a minimum level, it is to the interest of this nation to keep the energy source imports in
multiple hand rather than a single hand. Nuclear energy power plants will keep this
dependence even at a small rate under a limit! It is another fact that we have delayed in having
nuclear energy technology possessed by Turkey. Turkey should not be back in this technology
and know how should be possessed by Turkey. Furthermore, along with the needs of the
Country, it should be sold to other countries and to III rd World Countries after being developed.

Today, about one fifth of the World electricity production are being supplied from the nuclear power plants for a long years of time. (This became widespread after the 1973 energy crises). This rate is changing according to countries. In (Figure 2) in form of example, it is indicated that USA meets 16% of the energy from nuclear energy power plants and BRD at the rate of 30%, Japan at the rate of 10%, Belgium at the rate of 60%, France at the rate of 65%, England at the rate of 19%, Switzerland at the rate of 16%, Taiwan at the rate of 53%. Despite certain anxieties about nuclear power plants about their safety, in some assessments made, the probable valid accident rate for 100 reactors is about one in ten thousand /2-7/. Of course, the size of destruction to occur in case of a probable accident is unknown as compared to others but this is the negative direction of the safety factor. It is estimated that with the energy price increases in future, (Figure 3) the price of energy generated from the nuclear energy power plants and the operating costs will be very much cheaper than the other conventional power plants. In sum, at present, the nuclear energy power plants is the alternative that has the widest market chance, high technical economic availability (Continuity, Yield, Big Power, Limited Chimney and Furnace wastes etc...)

II. NUCLEAR ENERGY: CERTAIN DIFFERENT ASSESSMENTS

- More economic. For example: The cost of energy generated in the nuclear energy power plants changes in the interval of 1 kWh=25.000 TL through 30.000 TL. Whereas the cost of having energy from an equivalent thermal power plant is about 35.000 TL to 40.000 TL for 1 kWh. By using 1 kg uranium-235 in reactor the amount of energy generated is equivalent to energy generated by burning 30 ton coal or 20 tons of natural gas. The electricity energy by burning 1 tons of coal or 750 kg petroleum or 900 cubic meter of natural gas is 3000 kWh /4,7/.

- Damage to environment is negligible as compared to other fossil based energy power plants. Mixing of the Chimney and furnace wastes, gases and exhaust gases originating from thermal power plants with the atmosphere, their accumulation is resulting in having anxieties that they’ll be creating damage in future that can not be estimated now. Such as, tearing of ozone strata further and becoming power and resulting in disturbance in natural balance.

- As observed in the III rd World countries, in Turkey the cutting of trees from the forest areas which is considered as the lung of the globe are also continuing in Turkey for use as good for burning.

- By using nuclear energy power plants, especially for the future generations, the necessary industrial raw materials, petroleum, coal, natural gas will be protected.
- The radioactive rays spreading to environment from the nuclear energy power plants currently generating energy are less in density that the harmful light rays emission from the screens of the television /4/.

- Amount of energy to be generated from a medium sized nuclear energy power plant corresponds to energy generated by 1500 each normal sized wind mill by assuming that there will be wind blowing at all times.

The operation principle of the nuclear power plants /4,7,9,10,12/:

Uranium (3% U235, 97% U238) by exploding in chain under control with notron of the uranium core in the reactor boiler is braking into parts and the heat energy generated from this is directed to have water vaporized. Vapor generated by using different methods are supplied to turbines and mechanical energy is attained from the heat energy. The mechanic energy by means of a generator coupled to turbine shaft is generating electricity energy and it is transferred to the distribution-transport network (Figure 4-6) /4-7,11,12/. It is known that Turkey has a sufficient technical infrastructure that can compete with external countries in filed of making both the thermal and hydro electric power plants. The problem may be the reactor boiler which is one of the main structures. There is no doubt that this can be overcome in a short time.

III. PROBLEMS RELATED TO BUILDING NUCLEAR ENERGY POWER PLANTS IN TURKEY

On the subject of building nuclear energy power plants there are reactions as in the World in Turkey too. Without discussing the right ones here, one of the important anxieties the reactor safety will be looked at in this study;

- There is uncertainty with respect to size of the damage to be created as a result of a probable accident in environment and for the human life.
- Steeling radioactive materials from reactors, their use as a means of exerting pressure by illegal organizations,
- Having nuclear arm manufacturing go out of control and reach at a diminution that threatens humanity,
- Safe storage of radioactive fuel wastes, their destruction and problems related to them.

Along with these, there are other problems valid for Turkey and they will be touched at without assigning a priority to them:

- High cost of building, long construction period
- Financing source
- Ability to find unconditional and suitable loans
- The conditions to adopt oneself to the world standards rather than the conditions of the country
- Related legislation, uncertainty of areas of responsibility
- Externally dependent reactor fuel, its price to go up in future,
- Meeting certain reactor equipment by imports from abroad
- Certain political difficulties, obstacles expected to arise during technology transfer. For example like the difficulties encountered in arm orders to import arms from external countries and alike obstacles
- Turkey being completely a earthquake region in I st and II nd degree
- Local and regional political instability.

Contrary to certain researchers, scientists, in building nuclear energy power plants, their operation, maintenance and repair, attaining their safe keeping there are sufficient number of qualified manpower in Turkey and in the country the technological infrastructure is existing for making these power plants except certain units. This technology can be developed by the Turkish entrepreneurs in future and I have no doubt that they can be manufactured and put into the world markets. Technological accumulation and industry in Turkey is sufficient for building nuclear power plants. Problem is political and depends more on financing source. It is delaying at a degree for not having the required diligence, trust.

IV. MOBILE NUCLEAR ENERGY POWER PLANTS

In Turkey, along with the financing problem on the subject of building energy power plants, there is the fact that almost entire country is considered to be in the I st and II nd degree earthquake region and there are earth quake fays almost everywhere. Therefore, their being built in Turkey is bearing a great risk. There is need for ample amount of water for use in cooling reactors and the waste water after processing has to be drained outside. Along with these, the building costs are high and to reduce the long construction time to a minimum level, by taking into consideration the method of construction and assembly at the site like Turkey, the III rd World are seen as places that brings in mind having different nuclear power plant building designs. One of them is to assemble nuclear energy power plant on a diving, floating, a conventional ship platform and to operate it there. With this type of building style, many of the risks creating a problem for nuclear energy are removed and lessened. One can put into sequence certain positive characteristics of mobile building style as follows:

1. It is more safe against natural disasters like earthquakes,
2. Safety control can be made more effectively and safely
3. There is immediate response against possible operating accidents and sabotage
4. By filling water to certain sections of the ship it can be sunken partially or fully into the water that is into the depth of the sea. Thus, nuclear ray emission to environment and the probable nuclear explosions are prevented
5. In case of a probable risk of explosion, the ship can be drawn to open sea and down to the deep sea where the rescue operations can continue there
6. Sinking the ship into the deepness of the water for nuclear danger that may rise because of unavoidable chain explosion and fires...

7. The mobile nuclear energy power plants can be fixed at their construction site, near maritime ship yards, at suitable locations on the shore following their building with international cooperation by floating and fixing them there.

8. Energy generation can start under the international safety specialist control

9. The energy generation ports of the ship can be at different regions according to needs. For example, when a conventional energy power plant in any region or in neighboring country, is out of service for a long time, by anchoring at a energy port that is near to it, electric energy can be supplied with the normal electricity lines.

10. Renting mobile nuclear energy power plants for defined periods of time

11. Mobile nuclear energy power plant building, is suitable for development of the developing countries that are in political insatiability to supply the necessary energy in a safe manner. That is, these ships will be rented for a defined periods, at the energy port, under the international observance, the energy will be supplied.

12. Mobile energy power plants may also have area of use in having drinking water produced from sea water, to have dry areas and deserts become green.

13. Mobile energy power plants by being put into operation on days and hours in which there is a dense electric energy use can provide supporting electricity energy as well as it can be used in attaining hydrogen gas fuel in normal times.

14. Nuclear energy power plants can be considered for meeting the energy needs of islands such as Cyprus, Grit.

15. During crises, war times, this mobile nuclear power plants can be hidden in more secure places, by being buried into the water, has the capability of continuing generation of electricity.

16. Nuclear energy power plants form one of the important targets of the uncontrolled wars and terror attacks. The damage to be created by bombing a mobile nuclear energy power plant floating on the water is almost none as compared to damage that will arise after bombing a mobile nuclear energy power plant on the land.

Negative aspects of Mobile nuclear energy power plants:

- The building and operating costs are initially estimated to be high!
- Difficulty and high cost of underwater maintenance and repair works
- Corrosive effect of the sea water.
- Disturbances that may arise due to severe storms
- Having an operation life limited to 20-25 years

The important disadvantages listed above, may be reduced with certain constructive intervention and using new technologies and materials. It is definite that the cost of building them will be
high because of the high technologies. However, since they can be made in manufacturing places, these costs will balance each other. With different designs, semi mobile nuclear energy power plants and standard manufacturing of same version more than one unit, the cost of building them may also be reduced further. Different designs will be assessed in a different study.

V. METAL/STEEL STRUCTURE DESIGNS

U-boats operating with nuclear energy, aircraft ships may be considered as a mobile nuclear energy power plant. The power supplied to the propeller for moving the ships, (Figure 4-6) can be completely supplied to generation of electricity. May be limited but in emergency cases, it is possible to transfer electric energy to land areas from these ships. New mobile ship draft designs are given as designs in (Figure 7-14) that are adaptable to energy production by keeping the more powerful reactors on them. According to the movement characteristics the conventional ship housing the floating, diving Catamaran type mobile nuclear energy reactor on it is a combination that is developed by using the floating (catamaran) and diving (SWATH) ship types. /8,9/ Mobile a conventional ship type contains for main sections:

1. Floating lifting bodies
2. Carrier bodies
3. Platform
4. Nuclear reactor

A conventional ship types has the following positive aspects:

- Good maritime characteristics
- Good stability according to its width (stable balance)
- Not effected much from sea with waves
- High maneuverability
- Poor danger of sinking after an accident
- Wide and rectangular shaped deck areas, storage area and halls
- Suitable for carrying light weight but high level loads
- Capability to have rapid cargo loading and unloading
- Capability of changing the water depth of the ship at certain scale
- Multi purpose usage

During movement, since the wet area is large, the viscous friction resistance increase, this results in higher operating cost and along with the longitudinal resistance, especially in sea conditions where there are waves, with heavy load forcing, the resistance across the body and the resistance against winding are taken into consideration. These are the negative aspects of the a conventional ship.
Floating lifting bodies;

The forms and dimensions of the sectoral structures are determined according to the objectives for using the ship and to the size of the reactor. For example, for the Gas/Petroleum drilling islands (platforms) the building, manufacturing of these bodies are made by using simple and low cost pipe shaped materials and only the end points are realized to be sharp ended, (Figure 7-10 ). Pipes can be made in circular or elliptic shapes and there and more lifting boding bodies can be considered. The lifting and carrying bodies in possible accidents contains intermediary sections that is water proof against having water and sunk. This sectional structure type, increases the operation resistance of the ship according to its width and length. Engines making movement of the ship possible are in the lifting bodies. Depending on request, it is possible to design main units that carries ship (mobile) and the ones that are carried (fixed).

Carrying bodies;

Carrier bodies are narrow, long Y shaped by considering suitability to fluidity and connections and for bending moment forces, (Figure 10 ) . As it can be seen from (Figure 5), the lifting body and the platform, it provides the connection. The lifting body may be build with sections that has no water proofing. They are seen to function as spare lifting body. (Figure 9)

Platforms;

are the sections that connects the deck section, lifter and carrier bodies to one another and carries nuclear energy units like Reactor (Figure 7, 9) and the control command, operation, recreation and residence groups on it. With the purpose of reducing the weight of the ship, it can be build by using light but sound material. For example, aluminum alloys can be used.

Nuclear reactor and other units;

(control and commend centers converting nuclear fuel to energy, transferring electric energy to land) continued in the power plant building are being assembled on the platform. (Figure 5-7, 9)

The ship, at times deemed necessary, like fire, radioactive leakage etc. in from of operating accident, in crises period, stormy weathers or during loading and unloading cargo, by taking water into the water tanks present in the lifting and carrying bodies of it, can be buried completely or partials into the water and has the capability to move and at times necessary, in good weathers, like normal catamaran, has the characteristics of sealing in the sea. To securely encore the ship, it must be supplied with legs that extends to the sea bead with sufficient length and number. According to list containing demands and to reduce the cost of building considerably, mobile nuclear energy power plants can be designed to be able to move only on the water and loaded at their condition in form of a duba or platform.

The geometric shape of the ship, its dimensions depends on the type and power of the reactor to be selected. Currently, the types, powers and dimensions of reactors are determined as standards. (Figure 6) contains important dimensions of the reactor types /4,7,9,10-12/.
According to these values, the length of a medium sized reactor building, according to type is changing between 30-50 meters. It is not a problem to integrate a structure in this size to the platform of the ship and it can be easily realized. This subject will be published in a detailed separate study.

VI. NUCLEAR ENERGY POWER PLANT SHIP DESIGN

When the technical-economic value table containing weighted criteria such as economy, ease of building and safety, an opinion is gained that building double bodied, semi sunk a conventional ship, will be more suitable. It can be thought as a combination of good characteristics of the Catamaran and SWAHT ships. (Figure 12-14)

Main dimensions:

The full lengths of lifting bodies is 150 meter, circular cross section diameters 7 m, they are selected as cylinders with ends sharpened, (Figure 12-14) The building of this form is more easier and economical as compared to other forms. Furthermore, this form is more resistant to operating forces. Selecting a bit bigger diameter for the lifting bodies has the other objective of providing space for reactors and temporary nuclear fuel waste storage. Furthermore, for extension building works, displacement is increased. Displacement of two lifting body is 9861 tons. The distance between two lifting body, is 28 meter in the center. In general, the ship will be without movement in the port with anchored state, the values friction due to wet area is not taken into consideration as important. In this lifting bodies, there are electricity motors that are coupled with propellers attaining movement. The speed of the ship with its means is planned to be 5-6 miles Per hour. These main structures are under the water and therefore in case of a probable nuclear accident, they are forming a safety. Whereas the carrier bodies has the 140 meter as the full length and 4 meters width and a high of 5 meter.(Figure 12,13) They are rectangular with sharp ends. The addition displacement they bring in is about 1400 tons. The displacement of the ship is approximately 11000 tons. The base height of the platform connecting two main structure is 2 meter, with 40 meters, length about 155 meters. The area of the platform is about 6000 square meters. The other annex structures of the platform and their height is shaped according t6o the type and power of the reactor and their numbers. Where, there is a platform with covered ceiling having 5 meters of height. In form of building material steel is contemplated. Whereas, it is contemplated that, the wet surfaces of the lifting bodies that are under the water are to be coated with a material that is resistant to sea water. Other geometrical shape and main dimensions of a conventional nuclear energy power plant are given in general plan which is a draft.

VII. CONCLUSIONS

- Nuclear energy power plants is one of the important alternatives for development of Turkey and energy independence. There is benefit to start building these power plants at a time that is before the contemplated date.
During building, operating, attainment of the safety, repair and maintenance of the nuclear energy power plants, there are sufficient number of qualified personnel in Turkey to do it. The technological infrastructure of the country is sufficient to have these power plants possessed.

Since almost all of Turkey is considered to be in earthquake region, by taking into consideration the water potential and other factors, there are different building designs that one can take into consideration. For example, like the floating nuclear energy power plants. Installing the reactor on the platform of this ship, operating it without problem for 25-30 years is possible from the technical angle. This unit can be conformably built in a normal ship building yard in Turkey.

Project like or Turkey can be important for attainment of the energy safety that is necessary for development of the IIIrd World countries and support can be provided.

The most important problem is the financing problem and finding loans at low prices.

REFERENCES

1. Özden H. "Günes, III. Dünya Ülkelerinin umut enerjisi"
3. N.N. "Energie im 21 Jahrhundert - Betrachtung zur Entwicklung des Welt-Energieverbrauchs" Deutsche Shell AG
5. Sahin S., "Nükleer enerji tesisleri yapımı " 1987 sanayi kongresi bidiriler kitabi, yayın no 127, s. 171-188, tmmob, makine mühendisleri odası , Ankara
11. N.N. "Druckwasserreaktoren" Thiemig 1979, D - München
**Figure 1.** Resources of the energy production in the world

**Figure 2.** The distributions of the nuclear energy in the world
Figure 3 The increase of petrol during the last two years in Turkey

Figure 4. A ship plan in working with 38 MW, 11000 WPS nuclear energy (NS OTTO-HAHN, L=172 m, B=23.4 m, H=14.5 m, T=9.2 m.), [12].
Figure 5  The nuclear energy central in the ship. [12]

Figure 6. Technical data of the light nuclear reactors. [7]
**Figure 7** A mobil nuclear energy

**Figure 8.** Side view of unconventional ship
Figure 9. Middle cross section of unconventional ship

Figure 10. The geometry of the floating and buoying body
Figure 11. Loads occurring at the middle of unconventional ship

Figure 12. Platform and lifting hull of unconventional ships
Figure 13  A mobile floating nuclear energy power plan
Figure 14. Small model of unconventional ships